SECTION 11

STRUCTURAL DESIGN

11.1 CODES AND STANDARDS

The requirements of the following codes and standards, as amended for 155 mph wind, will apply to the PSRP pump stations as noted herein:

AISC – American Institute of Steel Construction, Inc. - *Manual of Steel Construction, 9th Edition*

ASTM - American Society for Testing and Materials

The Florida Building Code (2004)

Major Pump Station Engineering Guidelines (SFWMD, November 29, 2004)

Standards for Construction of Water Resource Facilities, Design Details (SFWMD, April 2005)

ACI 315 - American Concrete Institute, *Details and Detailing of Concrete Reinforcement*

ACI 318-99 – American Concrete Institute, *Building Code Requirements for Reinforced Concrete*

ACI 350 - American Concrete Institute, *Concrete Sanitary Engineering Structures*

AWS D1.1-2000 – American Welding Society, *Structural Welding Code*

COE EM 1110-2-2000 – *Standard Practice for Concrete for Civil Works Structures*

COE EM 1110-2-2101 – *Working Stress for Structural Design*

COE EM 1110-2-2102 – W*ater Stops and Other Preformed Joint Material for Civil Works Structures*

COE EM 1110-2-2103 – *Details of Reinforcement*

COE EM 1110-2-2104 – *Strength Design for Reinforced Concrete Hydraulic Structures*

COE EM 1110-2-2105 – *Design of Hydraulic Steel Structures*

COE EM 1110-2-2502 – *Retaining and Flood Walls*

COE EM 1110-2-2504 – *Design of Sheet Pile Walls*

COE EM 1110-2-3104 – *Stability of Structure*

The following SFWMD Standard Design Details will be utilized or referenced in the Design Drawings in Appendix 11- A located at the end of this Section:

TITLE	DRAWING NO.
Concrete Details	S1
Wingwall Fencing	S2
Dewatering Needle	S3, 1of 3
Dewatering Needle Beam	S3, 2 of 3
Dewatering Spreader Beam	S3, 3 of 3
Needle Beam Recess	S4
Structure Handrail	S5
Structure Ladder	S6, 1 of 2
Structural Ladder And Basket Guard	S6, 2 of 2
Wall And Anchor Rod Connection Details	S8, 1 of 2
Typical Wall And Wingwall And Pile Cap Connection Details	S8, 2 of 2
Pump Station Trash Rack	S9

11.2 DESIGN LOADS

The following Uniformly Distributed Live Loads shall form the basis of design for the facilities:

Live loads: **Pounds/Sq. Ft.**

Roof: (with parapet walls): 50

Roof: (without parapet walls): Wind load plus 20 PSF plus equipment, piping and other collateral loadings, or 5,000 lbs. Concentrated load at mid-span, whichever is greater.

Floors:

Operating floor (non equipment areas)	250
Operating Floor (equipment placing areas)	250*
Control Room	250
Restroom/Locker room	100
Equipment and Storage Rooms	200
Maintenance Work Area	300
Stairways	100
Elevator Lift & Handicap Ramp	200
Deck Grating	250
Service Bridge	HS-25**

Handrails:

Both loadings must be satisfied

200 lbs at any point and in any direction

50 lbs/ft horizontal with 100lbs/ft vertical applied simultaneously at top of rail

Dynamic Loads of Equipment (if any)

* Designated operating floor areas will be designed to support the heaviest piece of machinery anticipated to be placed thereon, or the previously noted uniform loading, whichever is more conservative.

** Service bridge shall also consider SFWMD 40 T truck crane loading, P&H 440TC.

Dead Loads:

Concrete: 150 PCF

Equipment: operating weight of equipment

HVAC Duct and lighting: 5 PSF total

Factors of Safety:

Buoyancy: 1.1 without top slab; 1.5 completed structures

Sliding: 1.5

Overturning: 1.5

Seismic:

Check for seismic loads per ASCE 7-02

Wind:

Velocity:	155 mph
Use Factor:	1.15
Exposure Category:	Exposure C
Mean Recurrence Interval (MRI):	I=1.51

Stability:

Analysis will be made for stability of structures against overturning, sliding, floatation and foundation pressure. Live loads, equipment weight, soil friction and cohesion on the alls will not be used to calculate the resisting dead weight of the structure for floatation. The structure will be designed to resist the full uplift pressure from normal water level elevation while empty.

Vibration:

The natural frequency of the supporting structure must be significantly different from the frequency of the inducing force. As the two frequencies approach each other, resonant vibration can occur with disastrous results. Accordingly, to minimize the possibility of resonance, the ratio of the frequency of the structure to the frequency of the equipment shall be greater than 2.1. This will prevent the equipment from passing through resonance frequency during start-up or shut down.

The natural frequency of a system member of single degree of freedom is calculated by:

$$\omega = \frac{\sqrt{\Delta st}}{3.13}$$

where ω = fundamental frequency

and Δst = static deflection due to its own weight (inches)

11.3 REINFORCED CONCRETE DESIGN

The ultimate strength method for structural design of reinforced concrete structures will be used, with analysis in general conformance with the American Concrete Institute, ACI 318-99, and

special requirements for Environmental Engineering Concrete Structures in general conformance with ACI 350.

Minimum compressive strength (fc'):

Precast or prestressed concrete: 5,000 psi

Building or equipment foundations, walls, and slabs: 4,000 psi

Driveways, curbs and gutters, and sidewalks: 3,000 psi

Fill concrete: 2,000 psi

Concrete Reinforcing Steel:

Bars: ASTM A615, Grade 60 (ksi) deformed bars

Bars requiring welding: ASTM A706, Grade 60

Welded wire fabric: ASTM A185 plain type; flat sheets

Maximum spacing not to exceed 12-inches

11.4 STRUCTURAL STEEL DESIGN

All structural steel shall be designed in conformance with the design requirements specified in the AISC Manual of Steel Construction, Ninth Edition.

Deflection: The following live load deflection criteria will be considered in design, where L = maximum distance between supports:

Beams, lintels or slabs supporting masonry: L/720

Floor plates and grating: L/360

Roofs without ceilings: L/240

Roofs with ceilings: L/360

Structural Steel Design: A36

Corrosion Resistant Steel: Type 304 Stainless Steel

Bolts: A325, type 1

Sheet Piles: Type A 328 or A 572 (grade 50) hot rolled

Coatings: Components exposed to weather shall be hot dipped galvanized

11.5 MASONRY

Concrete masonry units will be hollow load-bearing units conforming to ASTM C90, Grade N-I, Type II with normal weight aggregate complying with ASTM C33.

Masonry Reinforcing: Ladder type galvanized steel construction with 3/16-inch, 9 gauge side rods with 9 gauge cross ties.

Spacing: 16-inches on center and first and second joints above and below openings.

Expansion joint: Cross-type preformed rubber at 40-feet nominal spacing, at 10-feet from corners and/or where required to control expansion.

SECTION 11

STRUCTURAL DESIGN

APPENDIX A

SFWMD STANDARD ARCHITECTURAL DETAILS

TITLE	DRAWING NO.
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